HI AND DUST IN THE HIGH LATITUDE DARK CLOUD L1642

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Abstract. We have mapped the high latitude dark cloud L1642 ($l=210^{\circ}.8$, $b=-36^{\circ}.7$) in the 21-cm HI line using the 100-m radio telescope at Effelsberg. A remarkable HI line broadening from 2.5 to 2.9 km/s is observed over a small area on the "bright side" of L1642, i.e. the side facing the galactic plane. Results are presented concerning the effects of the asymmetrical UV radiation field of OB stars on the HI gas and the very small dust grains associated with L1642.

RESULTS AND DISCUSSION

The line width map of HI (Fig. 1) shows an increase from 2.5 to 2.9 km/s near the centre of the L1642 cloud peaking on the "bright side" of L1642. The spectra are narrow and do not reveal any sign of a second velocity component which could explain the line broadening as a blend effect. Although an explanation in terms of increased turbulence cannot be excluded, the fact that the IRAS 12μm surface brightness map of Laureijs et al. (1987) shows a maximum at the same position as the HI line broadening maximum (see Fig. 1) supports the thermal line broadening model where the heating of the HI gas is due to the photoelectric emission from very small grains and/or PAHs.

Assuming that the turbulent and large scale motions are the same in the broadened HI line region and immediately outside this area a temperature enhancement of 47 K is obtained for the HI gas. Adopting for the L1642 HI cloud the temperature $T_k = 81$ K, an average value for diffuse clouds (Spitzer and Cochran, 1981), the increase of the HI line width corresponds to an increase of T_k from ~80 to 130 K.

A simplified thermal balance model where the photoelectric heating function of very small grains (Spitzer, 1978) is balanced by the cooling functions of C^+, CO and C (Langer, 1976) can explain a ~50 K temperature enhancement if the mean projected surface area of grains/cm^3 per H atom is $2.0\ 10^{-21}$ cm^2. This value is consistent with the value of dust area as given by Spitzer (1978) if the extinction efficiency for these small grains is $Q_e \sim 1$. The requirement for additional grain area can be fullfilled by introducing the very small grains.

A ridge of excess HI emission has been detected at the outer edge of the dark cloud on its "bright side". From Fig. 2 it is seen that the ratio $N_{HI}/N_H(tot)$ vs. A_V tends to be higher for the "bright side" than for the "shadow side" of L1642. Fig. 2 shows a general agreement between the $H+H \rightleftarrows H_2$ equilibrium model of Hollenbach et al. (1971) and observations for $A_V > 1.4$ mag which corresponds to the projected distance $\rho < 0.85\ R$ (R=cloud radius) from the cloud centre. Based on the observations of Opal and Weller (1984) we estimate that the background UV radiation field in the vicinity of L1642 is about two times stronger on the "bright side" as compared to the "shadow side" of the cloud. Adopting for the model calculations a radiation

field value half of that used by Hollenbach et al. (1971) we obtain the result shown by the dashed curve in Fig. 2.

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FIG. 1

The line width (FWHM) of HI in L1642. Unit is km/s. The right-hand cross is the centre of the molecular cloud. The dashed oval shows the maximum in the 12μm map of Laureijs et al. (1987), and the thin dashed line the direction of the galactic equator

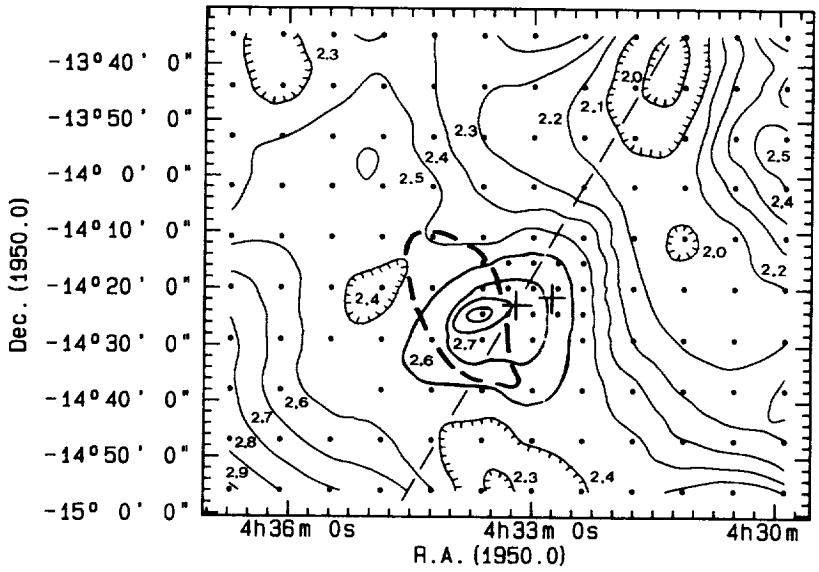

FIG. 2

The ratio $N_{HI}/N_H(tot)$ vs. A_V. The results of the "bright side" of L1642 are marked with open circles and the results of the "shadow side" with crosses. The three continuous curves correspond to the Hollenbach et al. (1971) $H+H \rightleftarrows H_2$ equilibrium model. The dashed line corresponds to a gas density of 9 10^3 cm^{-3} and to an ambient UV radiation field value half of that used by Hollenbach et al. (1971)